Acknowledgments

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Cynthia Bishop - Food Technology
Laura Rogers - Food Technology

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B. J. Williams, Jr.
E. R. Vieira

Introduction and Rationale for the Project

Efforts to promote the development of the aquaculture industry in Massachusetts are currently focused on both marine and freshwater activities While Massachusetts enjoys a long tradition of maritime occupations such as fishing, shipbuilding, and related industries, we also have an abundance of freshwater resources and an equally long tradition of utilizing those resources for the production and harvesting of fish. Included on the list of important species are trout, bass, yellow perch, and others

There are however, real limitations on the extent to which we can tax our freshwater resources for the commercial production of fish. Environmental and regulatory constraints make it difficult to establish new production facilities using freshwater ponds and/or flow-through facilities. As the demand for high quality fish increases, and the supply available from the natural fisheries continues to decline in both quality and quantity, it is inevitable that freshwater recirculating systems will become an increasingly important component in the aquaculture industry in Massachusetts

Much of the technology essential to the success of recirculating systems is already in place Physical and biochemical filtration systems have been developed which allow for high-density finfish production in excess of one half pound of fish per gallon of water Large scale production of hybrid striped bass and tilapia are currently underway in western Massachusetts by the firms of AquaFutures Inc. and Bioshelters Inc., respectively.

Continued efforts to develop freshwater aquaculture in Massachusetts will need to focus on

(1) the identification of additional species that may have potential for success in freshwater recirculating systems;

(2) development of the production technology needed for success of those particular species;

(3) evaluation of the public's acceptance of those species as a food commodity, especially where the species are not already an established part of the local diet

American yellow perch (Perca flavescens) has been identified as a freshwater species which may have potential for commercial aquacultural operations (1, 2, 3). Native to large areas of North America, yellow perch has been exploited since colonial times as both a recreational sportfish and in localized areas as a commercially valuable food commodity. It is highly valued as a food fish in the north-central region of the United States, especially in the areas immediately adjacent to the Great Lakes. The fish is described as having a delicious, delicate flavor, firm, white flesh, low fat content and minimal "fishy" flavor. It is a Saturday night "fish fry" favorite for the local population as well as an important main menu item in local restaurants. Retail prices for fresh yellow perch fillets in the Great Lakes region are reported to range from $8-11/lb in 1991 to $10-15/lb in 1994 (3).

In Massachusetts, yellow perch fillets are not generally available due to the absence of a commercial yellow perch fishery. Sportfishing enthusiasts have long regarded yellow perch to be among the most delicious of freshwater species. They are taken extensively throughout the summer on rod and reel and in winter through the ice. Recent concerns over water pollution and possible contamination of fish (especially by mercury) have dampened the public's enthusiasm for eating many freshwater fish taken from local waterways.

In spite of the obvious high regard for yellow perch fillets here and in other parts of the country, there are several constraints to the development of yellow perch as a viable aquacultural industry in Massachusetts. Among these are (1) the technology and economic feasibility for raising yellow perch in recirculating freshwater systems is largely undeveloped, although several research efforts are either underway or under consideration in New York and in the mid-west and (2) it is unclear whether the general public will accept yellow perch as a commercially desirable food commodity, especially in view of the fact that it is not widely established in Massachusetts as part of the local diet.

Statement of Goals

This project was designed as an integral part of the academic curriculum in Urban Forestry and Food Technology at Essex Agricultural and Technical Institute. Both programs operate at the two-year college level offering the Degree of Associate in Applied Science. Students conducted the work under the supervision of two senior faculty members, Busbee J. Williams, Jr., Department Chair for Environmental Technology and Ernest R. Vieira, Department Chair for Food Science.

The three specific goals identified for the project were as follows:

Goal # 1 - Establish the skills and technology necessary for the culture of yellow perch in freshwater recirculating systems. This phase was completed by students in Urban

Forestry and included the following activities

a. A literature search (including internet) for information available on the culture of yellow perch

b Grow-out of yellow perch from the fingerling stage to market size of approximately 1 25 lbs Accurate records were maintained on all major aspects of production including:

- water quality parameters
- visual assessment of different feeds (floating and sinking) on two separate populations of fish
- rate-of-gain (weight and length) for both populations of yellow perch
- percent yield for fillets at market weight

These activities were completed under the direct supervision of Busbee J. Williams, Jr.

Goal # 2 - Develop potential new food products and recipes using yellow perch.

Goal # 3 - Evaluate public acceptance of yellow perch as a food product. This was accomplished by presenting three different main-menu preparations to the patrons of Cafe-103, one of the Institute's student operated restaurants Each preparation featured yellow perch freshly harvested from the grow-out tanks. Restaurant patrons were asked to complete a standard food technology evaluation form which was then used to analyze the acceptance of yellow perch. Thirty five patrons (faculty, students, and guests) participated in the evaluation. All activities described above were completed by students in Food Technology and Culinary Arts under the supervision of Ernest R. Vieira, Patricia Kelly (Instructor in Culinary Arts) and Charles Naffah (Instructor in Culinary Arts).

Materials and Methods

Production and grow-out facilities

All production and grow-out activities were conducted at the Aquaculture Education Center at Essex Agricultural and Technical Institute The freshwater recirculating facility consists of a newly constructed 24 X 24 ft environmentally controlled fish barn capable of housing four 500 gallon grow-out tanks with supporting equipment and student workspace

The physical structures needed to conduct the study were assembled by students during the Fall-1997 semester. The primary system consists of two 500-gallon tanks sharing a common bead and biological filtration system powered by one 1/6 horsepower submersible pump This Model Aquaculture Recirculating System (MARS) was designed at the University of North Carolina to be used by schools planning to incorporate aquaculture into the curriculum A third tank, also 500 gallons, was assembled to hold an additional population of fish to be used as replacement for mortality losses, dissection specimens for the aquaculture classes, and general health observations. These fish were also used later for practice filleting and food quality assessment. The third tank is referred to as the "holding tank". A diagram of the original MARS is included The original system was modified to include bead filtration rather than the settling basin shown

Purchase and establishment of experimental fish populations

Approximately four hundred yellow perch fingerlings in the 3-4 inch size range were purchased from DelMarva Aquatics Inc. of Odessa, Delaware and shipped air-freight into Logan Airport on Friday, February 27, 1998. The fish arrived in excellent health with no shipping mortality All fish were acclimated slowly (over a 2-hour period) in the holding tank and held until the following Monday (March 2), when two populations of 125 fish each were established in the test tanks. In the process of transferring fisn to the test tanks, 20 fish from each population were netted out at random and measured for length (cm) and weight (gm). This data established the initial length and weight against which subsequent growth and development was evaluated

Selection of feed

The following two fish feed products were purchased through the local Agway Farm Supply outlet:

1. Rise, a rounded, floating pellet ranging from 1/8 to 1/4 inch in diameter is manufactured by Pro-Pet Corporation, of Syracuse, N.Y. Designed for feeding a wide range of farm-raised pond fish, Rise contains a minimum of 24 % crude protein.

2. Ziegler Salmon Starter #4 is a sinking starter crumble manufactured by Ziegler Bros Inc., of Gardeners, Pa. specifically for salmon in the 3-4 inch size range. Salmon Starter contains a minimum of 50 % crude protein.

Fish were fed twice daily (morning and afternoon) at an initial rate of 3% of body weight per day. On weekends and holidays, fish were fed once per day at the same rate. The automatic belt feeders purchased with the MARS were discontinued after one week due to unreliable operation. Fish were hand-fed for the duration of the project.

Problems, resolutions, modifications

1. The perch fingerlings showed no interest at all in the Rise floating feed pellets. Several attempts were made to modify the pellets (crushed into smaller granules and pre-soaked prior to feeding so they would sink) but the perch remained uninterested. They adapted readily however, to the Ziegler salmon starter. We discontinued the Rise product and maintained all fish on the salmon starter crumbles. The fish responded well during March and April, increasing from an average weight of 10.0g on March 9 to 17.8g on June 1. At that point the feed was changed to Ziegler's High Performance floating trout pellets, a larger (3/32 in) transitional feed. They adapted readily and continued to make good growth.

2. Turbidity problems in the two-tank system developed within two weeks after the fish arrived. Several attempts to solve the problem by modifying the bead filtration system and backflushing schedule were only partially successful. While the problem did not appear to have an adverse effect on the fish at that time, it posed a potential future threat due to the increasing bioload on the system as the fish continued to increase in size. Additional attempts to alleviate the problem included:

- Reducing the early rate of feed to 1.5% of body weight, a reduction of 1/2. This was necessary when it became obvious that much of the feed was not being consumed but was clogging the filters and contributing to the decline in water clarity. As the turbidity problems were gradually brought under control, the rate of feed was increased to approximate 2.6% of body weight.

- Backflushing the bead filters on a daily basis, rather than on an "as needed" basis.

- Flushing the sump tank as soon as any observable sedimentation had occurred

In spite of the on-going attempts to alleviate the turbidity problem, it became obvious during July that the two-tank (MARS) system was not going to support the two fish populations for the duration of the project. For this reason the two tanks were separated and reconfigured so that the MARS served only one population of fish. The second tank was redesigned to include a sedimentation chamber (35 gallons) to settle out the large solids and a 25 micron Ocean Clear cartridge filter to trap the finer suspended solids. The Ocean Clear cartridge also includes a biofilter core to provide biological oxidation of ammonia. This system had already been tested on the holding tank and appeared to work well. Turbidity problems were reduced to acceptable levels within 48 hours. The modifications described above remained in place for the duration of the project.

Data collection

Data collection for increases in perch weight and length began on March 9, 1998 and continued through July on a twice-monthly basis. On each sampling date 20 fish were netted at random from each of the two tanks and measured for length (centimeters) and weight (grams). It became evident over time that the process of netting, measuring, weighing and returning the fish to the tanks was introducing stress which might adversely affect their development. In order to minimize stress, data collection on a twice-monthly basis was changed to a monthly basis. This change remained in effect for the duration of the project.

Results

Results are presented in Table 1 (Weight of Perch (g) by Date), Table 2 (Length of Perch (cm) by Date, and Table 3 (Percent Yield at Harvest). In addition, all data presented in Tables 1 and 2 are summarized graphically in Charts 1 and 2, respectively. Tables 4 and 5 present water quality data.

Observations/Discussion

As noted above, persistent turbidity problems required that the two populations of fish be separated into systems which did not share a common water filtration system. It thus became difficult to determine if the minor differences in rate-of-gain were due to differences in feed (floating vs sinking) or some other parameter, such as water temperature, pH, oxygen or ammonia. For this reason, no attempt is made here to assess the effects of the different feeds on rate of gain.

Combining the data from both populations doubled the sample size (40 vs 20 fish per sampling date), resulting in improved reliability of results. The following observations are based on the combined averages of both populations:

- These perch grew relatively slowly. For the period Mar '98 - Mar '99 the fish grew from an initial average weight of 11.3g to 142.3g, an increase of 131g or approximately 12.6 times their original weight (Chart 1). While the graph looks impressive, the final weight averaged only slightly over 5 oz, well under 1/2 lb per fish. This rate-of-gain was substantially below our experimental goal of 1.25 lb. Additionally, the growth rate appeared to level off after 8 months, suggesting that the most rapid rate of increase had already occurred. Most perch raised for table use are marketed "in the round" at an average weight of approximately 113g (3). Such a weight may be difficult to market in Massachusetts, where consumers are accustomed to much larger fish.

- The rate of growth was highly variable within the population. The forty fish sampled in March '99 ranged from a low of 72.6g to a high of 224.9g. Some of the differences are likely sex-related (females grow faster than males) but may also relate to genetic variability within the population.

- Percent yield of fillets at harvest (Table 3) was low, averaging 14.9%. Variability ranging from 12.5% to 18.0% was due in part to size differences and the fact that students were unfamiliar with hand-filleting techniques. The smaller perch were especially difficult and time-consuming to process. Commercial yellow perch producers utilize automated processing equipment.

- Perch appear easy to maintain in freshwater recirculating systems. They adapted readily to the small (500 gallon) tanks at a concentration of 125 fish per tank. They exhibited no cannibalism or "eyeplucking" behavior associated with higher concentrations of fish. They adapted to commercially formulated feeds (except Rise) and readily accepted changes in feed as they grew larger. Observable disease problems consisted of a single instance of body fungus and several instances of muscle tumors noticed during the filleting activities at the conclusion of the project. All perch went "off feed" temporarily when an air conditioning problem allowed water temperature to rise into the high 70's (F). A minor problem with perch jumping from the tanks (always at night) was limited to the early months of the study.

- The floating feeds used in this study had advantages over the sinking feeds. It was easier to feed fish to satiation with floating feed because it was obvious when the feed had all been consumed. This was an important technique to help prevent excess organic matter from fouling the system. A second advantage was that the fish had to rise to the top when feeding which presented an opportunity to observe their behavior on a daily basis. A minor disadvantage of floating feed was that overly enthusiastic feeding would always result in some feed being splashed out of the tank. As noted above, differences in rate-of-gain could not be attributed to feed differences because of possible influence of other variables.

Conclusions/Comments

Prospects for a viable commercial yellow perch industry in Massachusetts depend in part on the ability of the industry to supply consumers with a high quality product at an acceptable cost. This brief study suggests that the technology for rearing yellow perch from fingerling to market size in recirculating systems is well within reach. The question of cost effectiveness however, is far from clear. Additional information is needed on maximum population densities attainable with yellow perch and the minimum length of time needed to reach market weight. It will be important to "engineer" populations of fish genetically disposed to rapid, uniform growth. Triploid genetic technology may now be available to develop monosex cultures of 100% female perch, whose rapid rate of growth will significantly reduce the grow-out period. Genetic selection for consistency in growth rate will produce uniform size fillets, a substantial advantage in processing and marketing fish.

The aquaculture industry will also need to consider the feasibility of grow-out operations that include both indoor recirculating systems and pond flow-through systems as well. The high cost of energy for heating, cooling, aeration and pumping of indoor recirculating systems may well be prohibitive if large populations of fish need to be held for an additional 6 months or more to reach market size. This cost could be reduced if perch were transferred to local ponds for the final grow-out phase. Such a system would be most effective if the transfers were scheduled in early spring and harvest scheduled for fall. Feeding, health care and harvesting technology for outdoor operations is probably already in place. Regulatory constraints will be a factor in Massachusetts.

Acceptance of yellow perch by local consumers remains an unanswered question. While local sport fishermen speak highly of the quality of yellow perch (taken from uncontaminated waters), the larger Massachusetts population has not been exposed to perch as a food commodity on a commercial basis. The taste evaluations conducted here indicate a high regard for perch as a main menu item but also indicate that price is an important factor in the decision to buy. Additional information on the public acceptance aspect of this study follows.

References Cited

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2. Kolkovski, Sagiv and Konrad Dabrowski. 1998. Off-Season Spawning of Yellow Perch. The Progressive Fish Culturist. 60:133-136.

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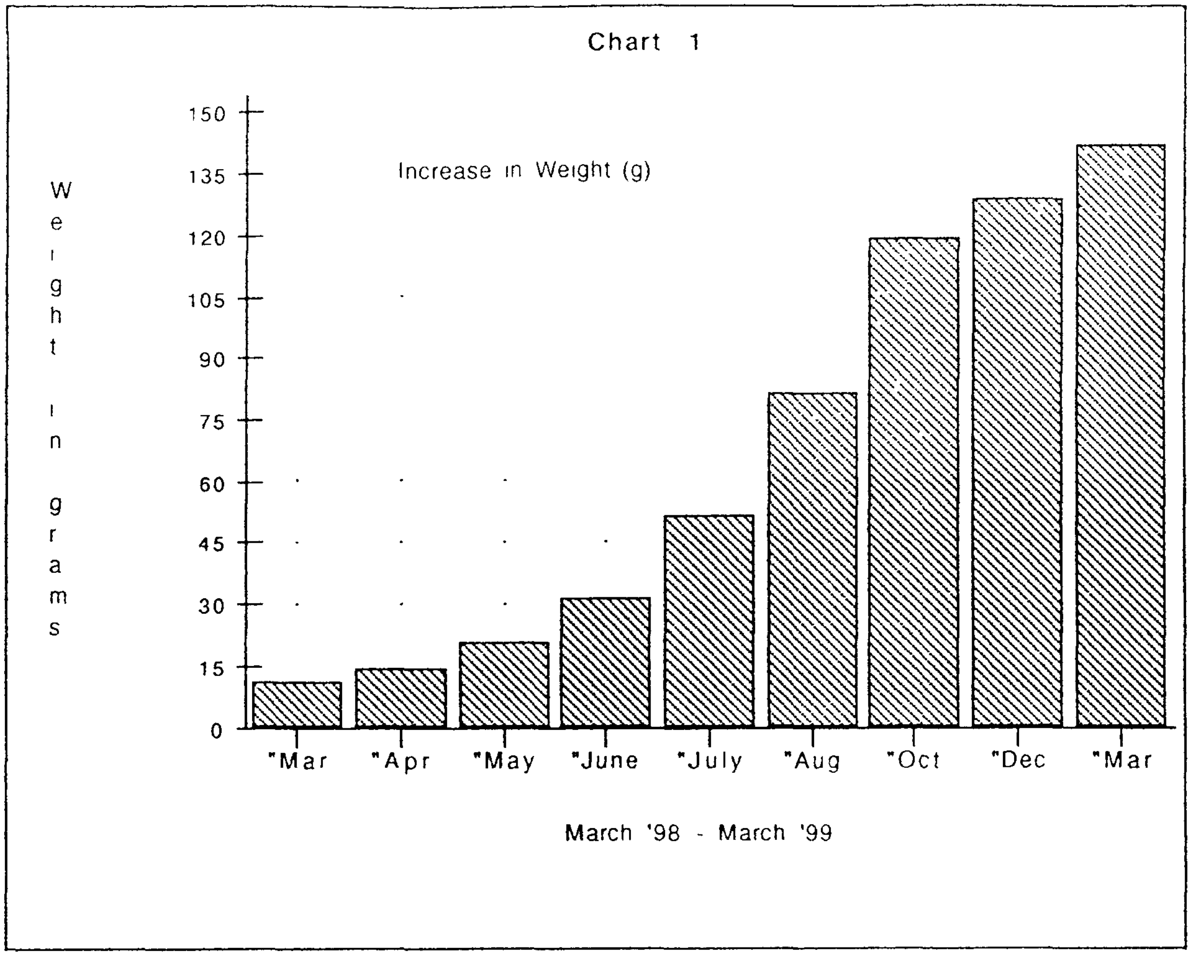


Chart 1
Increase in Weight (g)
Weight in grams
150
135
120
105
90
75
60
45
30
15
0
"Mar
"Apr
"May
"June
"July
"Aug
"Oct
"Dec
"Mar
March '98 - March '99

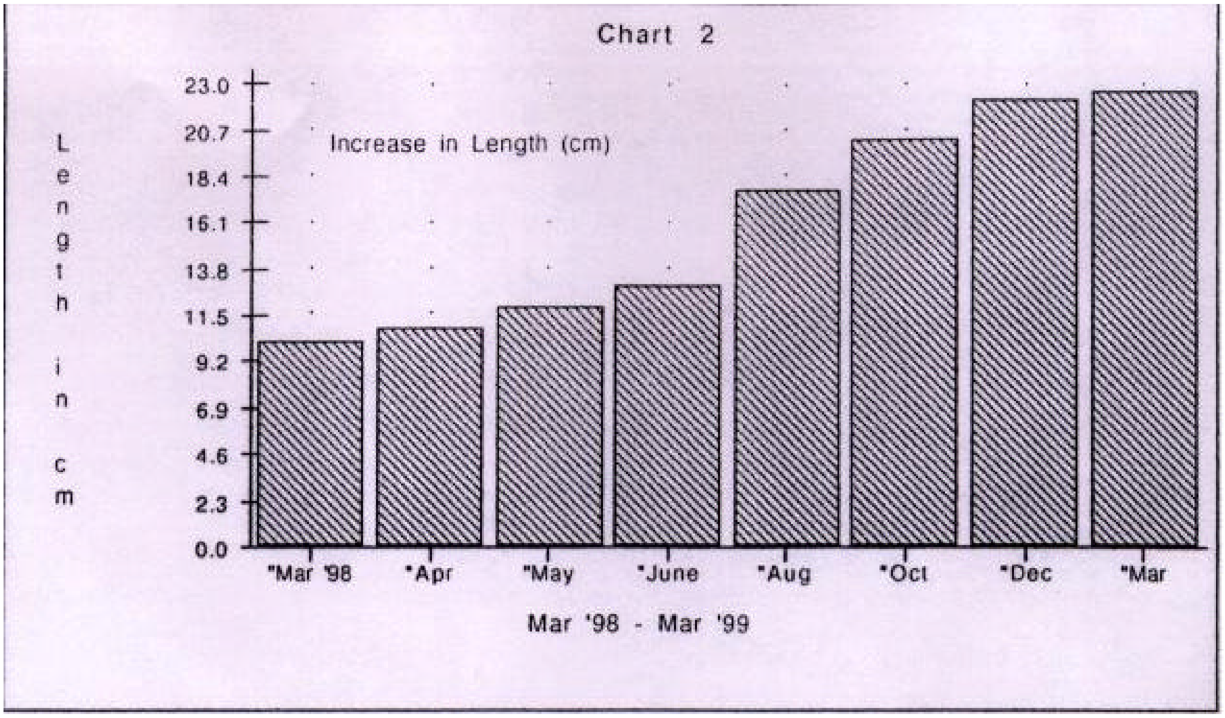
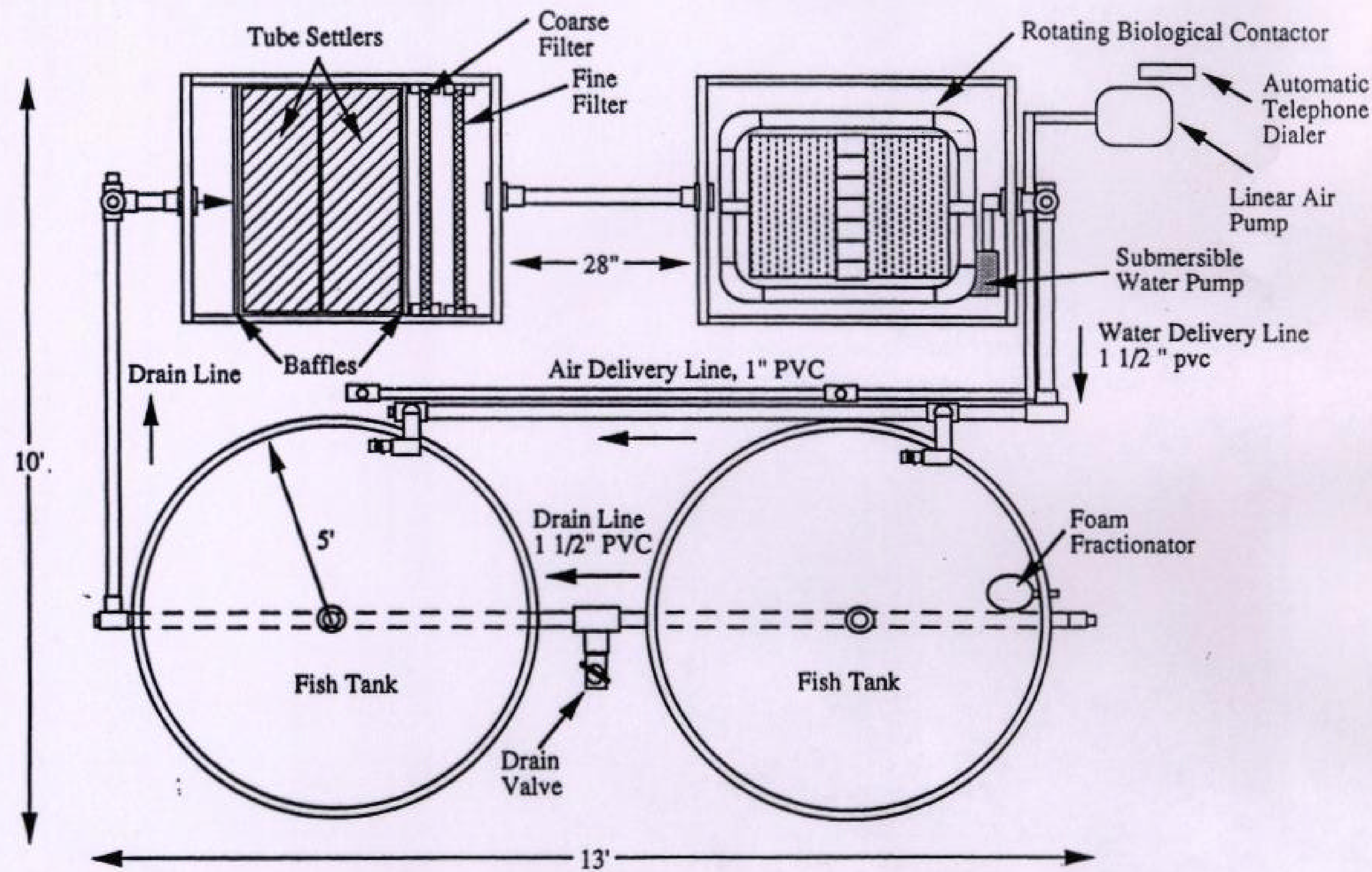


Chart 2
Increase in Length (cm)
Length in cm
23.0
20.7
18.4
16.1
13.8
11.5
9.2
6.9
4.6
2.3
0.0
"Mar '98
"Apr
"May
"June
"Aug
"Oct
"Dec
"Mar
Mar '98 - Mar '99



Overall Layout of the Model Aquaculture Recirculating System

Table 1 - Weight of Perch (g) by Date

Date of Sample	3/9/98			Date of Sample	3/23/98	
sample #	Tank # 2	Tank # 3		sample #	Tank # 2	Tank # 3
1	11 33	14 38		1	23 76	13 44
2	11 41	7.29		2	18 34	9.08
3	12 67	14.48		3	11.31	5
4	9.24	15.7		4	9.86	15 28
5	9.75	9 26		5	14 5	14.84
6	12.07	10 44		6	14 62	12.26
7	12.36	9.12		7	10.91	12.69
8	12.88	12.25		8	16.15	15.4
9	8.27	4.62		9	12.44	8.78
10	8.48	6.57		10	6.38	17.6
11	9.32	7.75		11	19.04	12.21
12	10.86	12.1		12	15 3	8.49
13	8.12	7.33		13	7.9	12.99
14	5.55	11 98		14	13.7	13.46
15	8.61	11 76		15	11.84	10.01
16	8.52	7.98		16	9.8	11.59
17	11.87	9.44		17	10.04	12.62
18	7.66	8.17		18	17.18	10.54
19	7.1	13 49		19	16.41	14.24
20	8.98	9 63		20	13.53	10.1
Average	9.8	10.2		Average	13.7	12
	Ave 2&3	10			Ave 2&3	12.85

Table 1 - Weight of Perch (g) by Date

Date of Sample	4/6/98		Date of Sample	4/17/98	
sample #	Tank # 2	Tank # 3	sample #	Tank # 2	Tank # 3
1	21.36	14.88	1	9.38	11.89
2	15.68	11.46	2	13.41	10.45
3	15.42	17.89	3	17.82	12.96
4	18.72	10.22	4	12.44	9.63
5	13.72	9.54	5	16.25	10.75
6	11.04	11.13	6	13.29	16.95
7	16.01	12.54	7	21.69	16.6
8	10.49	14.62	8	14.48	11.88
9	11.03	16.57	9	21.17	10.27
10	12.57	14.63	10	22.41	12.4
11	14.64	10.91	11	14.05	13.47
12	12.82	13.42	12	11.43	11.95
13	11.39	14.98	13	17.95	13.04
14	16.95	8.79	14	14.88	16.16
15	13.75	17.59	15	14.1	16.28
16	17.69	15.26	16	9.29	18.56
17	14.95	10.56	17	11.84	17.11
18	11.34	12.52	18	13.02	18.26
19	10.9	14.74	19	18.36	19.4
20	12.72	15.24	20	20.33	16.3
Average	14.2	13.4	**Average**	15.4	14.2
	Ave 2&3	13.8		**Ave 2&3**	14.8

Table 1 - Weight of Perch (g) by Date

Date of Sample	5/1/98			Date of Sample	5/18/98	
sample #	Tank # 2	Tank # 3		sample #	Tank # 2	Tank # 3
1	20.56	12.2		1	25.1	18.53
2	18.54	18.25		2	24.5	32.3
3	20.14	17.02		3	28.3	29.7
4	21.44	25.98		4	33.9	28.4
5	15.96	12.81		5	22.7	20.62
6	26.86	17.25		6	24.2	24.3
7	17.25	22.65		7	18.4	20.76
8	10.42	22.62		8	27.4	16.95
9	20.76	20.97		9	27.9	12.7
10	19.23	17.37		10	20.2	20.9
11	14.96	19.57		11	18.6	20.6
12	20.45	20		12	23.9	26.9
13	16.92	13.07		13	27	31.7
14	17.25	17.37		14	24.3	25.6
15	17.15	12.85		15	17.4	29
16	15.16	9.42		16	20	20.8
17	20.46	16.56		17	27.7	26.3
18	15.87	18.97		18	26.1	21.1
19	17.14	15.38		19	12	19.3
20	22.08	10.9		20	20.4	20.2
Average	18.4	17.1		Average	23.5	23.3
	Ave 2&3	17.75			Ave 2&3	23.4

Table 1 - Weight of Perch (g) by Date

Date of Sample	6/1/98		Date of Sample	6/15/98	
sample #	Tank # 2	Tank # 3	sample #	Tank # 2	Tank # 3
1	32 8	29 2	1	30 1	35 4
2	25.5	25.3	2	30 1	35.4
3	24.8	26.7	3	30 1	35.4
4	32.2	26.2	4	30 1	35 4
5	29.2	29.3	5	30 1	35 4
6	23.8	33.7	6	30 1	35.4
7	40.2	28.1	7	30.1	35.4
8	32.9	24.1	8	30 1	35.4
9	28.8	33.5	9	30.1	35.4
10	26.1	24.4	10	30 1	35.4
11	33.6	25.5	11	34.2	31.7
12	34.8	33.9	12	34.2	31.7
13	29.3	35 3	13	34.2	31.7
14	26.8	28.3	14	34 2	31.7
15	24.9	38.2	15	34.2	31.7
16	41.1	29.5	16	34.2	31.7
17	33.3	19.5	17	34 2	31.7
18	28.4	31.7	18	34 2	31.7
19	31.2	38.6	19	34.2	31 7
20	21.9	30.3	20	34 2	31.7
Average	30 1	29.6	Average	32.2	33.6
	Ave 2&3	29.85		Ave 2&3	32.9

Table 1 - Weight of Perch (g) by Date

Date of Sample	7/1/98		Date of Sample	7/16/98	
sample #	Tank # 2	Tank # 3	sample #	Tank # 2	Tank # 3
1	44.1	44.9	1	59.8	54.3
2	44.1	44.9	2	59.8	54.3
3	44.1	44.9	3	59.8	54.3
4	44.1	44.9	4	59.8	54.3
5	44.1	44.9	5	59.8	54.3
6	44.1	44.9	6	59.8	54.3
7	44.1	44.9	7	59.8	54.3
8	44.1	44.9	8	59.8	54.3
9	44.1	44.9	9	59.8	54.3
10	44.1	44.9	10	59.8	54.3
11	46.1	48.7	11	59.2	55.9
12	46.1	48.7	12	59.2	55.9
13	46.1	48.7	13	59.2	55.9
14	46.1	48.7	14	59.2	55.9
15	46.1	48.7	15	59.2	55.9
16	46.1	48.7	16	59.2	55.9
17	46.1	48.7	17	59.2	55.9
18	46.1	48.7	18	59.2	55.9
19	46.1	48.7	19	59.2	55.9
20	46.1	48.7	20	59.2	55.9
Average	45.1	46.8	**Average**	59.5	55.1
	Ave 2&3	45.95		**Ave 2&3**	57.3

Table 1 - Weight of Perch (g) by Date

Date of Sample		8/17/98	Date of Sample		10/8/98
sample #	Tank # 2	Tank # 3	sample #	Tank # 2	Tank # 3
1	79.4	79.4	1	119	113 4
2	79 4	79.4	2	119	113 4
3	79 4	79.4	3	119	113.4
4	79.4	79 4	4	119	113.4
5	79 4	79.4	5	119	113 4
6	79.4	79.4	6	90 8	147 4
7	79.4	79.4	7	90.8	147.4
8	79.4	79.4	8	90.8	147.4
9	79.4	79.4	9	90.8	147.4
10	79.4	79.4	10	90.8	147.4
11	76.6	90.7	11	130.4	136
12	76.6	90.7	12	130.4	136
13	76.6	90.7	13	130.4	136
14	76.6	90.7	14	130 4	136
15	76.6	90.7	15	130.4	136
16	76 6	90.7	16	102	119
17	76.6	90.7	17	102	119
18	76.6	90.7	18	102	119
19	76 6	90.7	19	102	119
20	76 6	90.7	20	102	119
Average	78	85	Average	110.6	128.9
	Ave 2&3	81.5		Ave 2&3	119.75

Table 1 - Weight of Perch (g) by Date

Date of Sample	12/3/98		Date of Sample	3/26/99	
sample #	Tank # 2	tank # 3	sample #	Tank # 2	Tank # 3
1	170 1	no data	1	195 6	194 6
2	141 8	no data	2	180.2	193 1
3	155 9	no data	3	224 9	72 6
4	113 4	no data	4	119.5	130 5
5	85 1	no data	5	150 7	159 4
6	127 6	no data	6	137 2	113 5
7	141 8	no data	7	134 1	123 2
8	85 2	no data	8	167 1	185.8
9	90 7	no data	9	195 8	157 5
10	177 9	no data	10	103 1	180 5
11	no data	no data	11	149.2	112 2
12	no data	no data	12	141.3	104 5
13	no data	no data	13	102 4	75 3
14	no data	no data	14	174 1	127.1
15	no data	no data	15	140 5	113 1
16	no data	no data	16	187 2	198 9
17	no data	no data	17	146 9	113 1
18	no data	no data	18	91 5	101 9
19	no data	no data	19	119 2	149 7
20	no data	no data	20	142 1	84 3
Average	128 9		**Average**	150 1	134 5
	Ave 2&3	128 9		**Ave 2&3**	142 3

Table 2 - Length of Perch (cm) by Date

Date of Sample		3/9/98	Date of Sample		3/23/98
sample #	Tank # 2	Tank # 3	sample #	Tank # 2	Tank # 3
1	10	9	1	11	13 5
2	10	11	2	9	11.5
3	11	11.5	3	7.5	10
4	10	9.5	4	11	9
5	9.5	10	5	11	11
6	10.75	9.75	6	10	11
7	11	10.5	7	10.25	9.5
8	11	8	8	10.5	11.5
9	9	9	9	9.5	10.5
10	10	9	10	12	8
11	10	10.25	11	10	12
12	10.5	8.5	12	9.5	11
13	9.75	11	13	10 5	9
14	8 75	11	14	11	10.5
15	9.75	9.5	15	10	11
16	9	10.5	16	10	9.5
17	11	9.5	17	10	10
18	9.5	9.5	18	9.5	12
19	9.5	11	19	11	11
20	10.5	10	20	10.5	10.5
Average	10	9.9	**Average**	10.2	10.6
	Ave 2&3	9.95		**Ave 2&3**	10.4

Table 2 - Length of Perch (cm) by Date

Date of Sample		4/6/98	Date of Sample		4/17/98
sample #	Tank # 2	Tank # 3	sample #	Tank # 2	Tank # 3
1	12	11	1	9 5	10 5
2	11 5	9 5	2	11	9 5
3	12	12	3	12	10 5
4	11 5	9.5	4	11	10
5	10 5	9.25	5	11 75	10.5
6	10	10	6	11	12
7	11.25	10 5	7	12.25	12
8	9.5	10 5	8	11.5	11
9	10	11	9	12 75	10.5
10	10 25	11	10	13	10.25
11	11	9	11	11	11
12	10	10.5	12	10	11.5
13	10	12	13	11 5	10.5
14	11	9.5	14	11 25	11 5
15	10.75	11.25	15	11.25	11
16	11 75	11.5	16	10	10.5
17	11	9.5	17	11	10.5
18	10	10.25	18	10.5	11
19	10	10.25	19	12	10.5
20	10	11.5	20	12	11
Average	10.7	10.5	Average	11 3	10.8
	Ave 2&3	10.6		Ave 2&3	11.05

Table 2 - Length of Perch (cm) by Date

Date of Sample		5/1/98	Date of Sample		5/18/98
sample #	Tank # 2	Tank # 3	**sample #**	Tank # 2	Tank # 3
1	11.5	11.5	1	12	12.5
2	11.5	11.5	2	13	13.5
3	12	12	3	13.5	13
4	12.5	13	4	14	12
5	11	10.5	5	12	12
6	12	12	6	12	12.5
7	11.75	12	7	11.5	11.5
8	9.5	12.25	8	12	10.5
9	12.5	12	9	13	10
10	12	11.5	10	12	11
11	11.25	12	11	11	11.5
12	12	11.5	12	11.5	12.9
13	12	10.5	13	13	13.3
14	11	12	14	12.5	13
15	11.75	10.5	15	11	13
16	11.5	9.5	16	12	11.9
17	12	11.5	17	13.5	13
18	11	12	18	13	11.5
19	11	11	19	10	12
20	12	9	20	11.5	12
Average	11.6	11.4	**Average**	12.2	12.1
	Ave 2&3	11.5		**Ave 2&3**	12.15

Table 2 - Length of Perch (cm) by Date

Date of Sample	6/1/98		Date of Sample	6/15/98	
sample #	Tank # 2	Tank # 3	sample #	Tank # 2	Tank # 3
1	13 5	13	1 - 20	no data	no data
2	13	12	2	no data	no data
3	12	12.5	3	no data	no data
4	13 5	12	4	no data	no data
5	13	13	5	no data	no data
6	12 5	14 5	6	no data	no data
7	14	13	7	no data	no data
8	13 5	12	8	no data	no data
9	13	13	9	no data	no data
10	12 5	12	10	no data	no data
11	13 5	12 5	11	no data	no data
12	14	13	12	no data	no data
13	13 5	14	13	no data	no data
14	12	13 5	14	no data	no data
15	12	14	15	no data	no data
16	15	12 5	16	no data	no data
17	13 5	11.5	17	no data	no data
18	12 5	13	18	no data	no data
19	13	14	19	no data	no data
20	12 5	13	20	no data	no data
Average	13 1	12.9	Average	no data	no data
	Ave 2&3	13			

Table 2 - Length of Perch (cm) by Date

Date of Sample		8/17/98		Date of Sample		10/8/98
sample #	Tank # 2	Tank # 3		sample #	Tank # 2	Tank # 3
1	18.5	19		1	21.5	22.9
2	17	18 6		2	22	19.5
3	15.5	17.6		3	20 8	19
4	19	17.2		4	20 8	18 5
5	20	17.5		5	19.5	18 9
6	19	17.6		6	20	23
7	17	17.3		7	18	21
8	17	18.2		8	18	21.5
9	16	18		9	18.7	20.4
10	15.5	16.8		10	18.5	20.8
11	15.5	19		11	19.8	20.4
12	19.9	17.5		12	22.5	19.6
13	18.3	19.1		13	21	21
14	17.9	17.1		14	20 2	22.6
15	15.9	17.8		15	20.5	22.4
16	16.1	19		16	20	17.7
17	15	16.9		17	19 1	20
18	19.5	18.2		18	18	19.5
19	18	20.4		19	22	21.3
20	17.2	20.3		20	19.8	20.2
Average	17.4	18.2		Average	20	20.5
	Ave 2&3	17.8			Ave 2&3	20.25

Table 2 - Length of Perch (cm) by Date

Date of Sample		12/3/98	Date of Sample		3/26/99
sample #	Tank # 2	Tank # 3	sample #	Tank # 2	Tank # 3
1	24	no data	1	24.7	25 3
2	22	no data	2	24 7	24.7
3	24	no data	3	27	19.6
4	23	no data	4	21 9	22 7
5	22	no data	5	23	22.9
6	26	no data	6	22.5	21 9
7	23	no data	7	21.9	22
8	21	no data	8	24	24.3
9	22	no data	9	24.8	24
10	25	no data	10	19 7	24.6
11	no data	no data	11	23.5	21 1
12	no data	no data	12	22 2	20.1
13	no data	no data	13	21.4	19.4
14	no data	no data	14	24	22 3
15	no data	no data	15	22.3	21.1
16	no data	no data	16	24.8	25.3
17	no data	no data	17	23.3	21
18	no data	no data	18	19.5	20.5
19	no data	no data	19	22	23.1
20	no data	no data	20	22 1	19 5
Average	23.2		Average	23	22.3
	Ave 2&3	23.2		Ave 2&3	22.65

Table 3 - Percent Yield at Harvest

	whole (g)	fillets (g)	yield (%)
1	195.6	35 2	18
2	99	14.2	14.3
3	219.7	38	17.3
4	150.7	25.5	16.9
5	91.5	11.4	12.5
6	187	27.1	14.5
7	112.3	16.8	15
8	144.8	20.9	14.4
9	128	16.5	12.9
10	163.9	22.1	13.5
		ave. yield	14.9

Table # 4 - Water Quality, Tank 2

Tank # 2

date	temp (F)	pH	d.o. (mg/l)	tan (mg/l)	NH3
3/5/98	57	7	12	no data	no data
3/15/98	62	6 9	9 5	no data	no data
3/22/98	67	6 8	12 5	no data	no data
4/6/98	69	6 7	12 2	no data	no data
4/18/98	67	6 4	11 9	no data	no data
4/27/98	69	6.5	13	no data	no data
5/5/98	67	5 8	8 5	no data	no data
5/18/98	68	5 9	12 5	no data	no data
6/7/98	69	5.6	14 4	no data	no data
6/13/98	71	5 5	12 1	no data	no data
6/25/98	73	5 6	6 4	no data	no data
7/10/98	70	6 7	5 8	no data	no data
7/26/98	67	6 6	7 2	no data	no data
7/27/98	68	6.6	6 6	no data	no data
8/9/98	66	6.5	6 1	no data	no data
8/10/98	66	6.6	6	no data	no data
10/12/98	68	6.3	5 5	no data	no data
12/2/98	66	5 9	5	no data	no data

Table 5 - Water Quality, Tank 3

Tank # 3

date	temp (F)	pH	d o (mg/l)	tan (mg/l)	NH3
3/5/98	57	7	12	no data	no data
3/15/98	62	6 9	9 5	no data	no data
3/22/98	67	6 8	12 5	no data	no data
4/6/98	69	6 7	12 2	no data	no data
4/18/98	67	6 4	11 9	no data	no data
4/27/98	69	6 5	13	no data	no data
5/5/98	67	5 8	8 5	no data	no data
5/18/98	68	5 9	12 5	no data	no data
6/7/98	69	5 6	14 4	no data	no data
6/13/98	71	5 5	12 1	no data	no data
6/25/98	73	5 6	6 4	no data	no data
7/10/98	70	6 7	5 8	no data	no data
7/26/98	68	6 6	7 2	no data	no data
7/27/98	68	6 8	6 6	no data	no data
8/9/98	66	6 5	6 1	no data	no data
8/10/98	68	6 5	6	no data	no data
10/12/98	67	6	5 5	no data	no data
12/2/98	67	5 7	5	no data	no data

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Aquaculture Demonstration Project

Final Report

Production and Marketing of Yellow Perch in Massachusetts

A brief study of the feasibility of growing American yellow perch (*Perca flavescens*) in recirculating freshwater systems and an examination of consumer acceptance

Submitted to the Massachusetts Department of Food and Agriculture
in fulfillment of requirements under
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